QUASI-CLASSICAL DYNAMICAL DETERMINATION OF THE BASIC PLANCK UNITS

Vladan Panković, Darko V. Kapor, Miodrag Krmar
Department of Physics, Faculty of Sciences, 21000 Novi Sad,
Trg Dositeja Obradovića 4., Serbia, vpankovic@if.ns.ac.yu

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Abstract

In this work all basic Planck units (Planck mass, Planck length, Planck time and Planck electrical charge) are determined by solution of a simple system of quasi-classical dynamical equations that have particularly classical (Newton gravitational force, Coulomb electrostatic force), relativistic (equivalence principle) or quantum (Planck-Einstein formula) nature.

As it is well-known Plank gave his remarkable system of the basic units, Planck mass, Planck length, Planck time and Planck electrical charge, without any deduction rule (algebraic formulas referring to some physical, i.e. dynamical principles) [1]. Practically, there is common opinion, that deduction of the basic Planck unit in low energetic domain, i.e. non-Planckian sector, represents nothing more than dimensional analysis only [2]. Situation would be quite different in high energetic, Planckian domain where new, to this time undone, quantum field theoretical and string dynamical laws have primary role [3].

In this work all basic Planck units (Planck mass, Planck length, Planck time and Planck electrical charge) will be determined by solution of a simple system of quasi-classical dynamical equations that have particularly classical (Newton gravitational force, Coulomb electrostatic force), relativistic (equivalence principle) or quantum (Planck-Einstein formula) nature.

Consider the following system of four equations

$$\frac{Gm^2}{R^2} = \frac{1}{4\pi\epsilon_0}\frac{e^2}{R^2} \tag{1}$$

$$\frac{Gm^2}{R^2} = m\omega^2 R \tag{2}$$

$$\frac{Gm^2}{R^2} = mc^2 \tag{3}$$

$$mc^2 = \hbar\omega. \tag{4}$$

Here m represents the mass of a system, e- electrical charge of a system, R - distance between two systems, and, ω - angular frequency, all of which can be considered as four unknown variables.

Also, in (1)-(4) G represents Newtonian gravitational constant, ϵ_0 - vacuum dielectric constant or permittivity, c - speed of light and $\hbar$ - Planck reduced constant.

Equation (1) can be, formally, interpreted as the dynamical equilibrium between classical Newton gravitational force (that originates from one particle with mass m and that acts on the other particle with the same mass m) and classical Coulomb electrostatic force (that originates from one particle with electrical charge e and that acts on the second particle with the same electrical charge e). It, in some degree corresponds to Stone concept by derivation of the basic units, especially basic mass [4].

Equation (2) can be, formally, interpreted as the dynamical equilibrium between mentioned classical Newton gravitational force and classical centrifugal force by rotation of the particle. It can be observed that instead of centrifugal force an elastic force of a linear harmonic oscillator or rotator can be used.

In this way both equations, (1) and (2), have, formally, a classical dynamical nature.

Equation (3) can be, formally, interpreted as the equivalence between potential energy of mentioned classical gravitational interaction and relativistic total energy of single particle. In this way given equation has dynamically a half-classical and half-relativistic nature.

Finally, equation (4) can be, formally, interpreted as the quantum, Einstein-Planck relation for energy of a quantum. In this way given equation has, formally, a quantum dynamical form.

Physical, precisely quasi-classical, meaning of the complete system of equations (1)-(4) is the following. Basic Planck units are quasi-classically determined by conditions that both classical force, gravitational and electrical, between two equivalent systems, are identically strong, as well as by quantum-relativistic condition that any of interacting system becomes comparable, even equivalent with quantum of given interactions. (Emission and absorbtion of interaction quantum can be, in the first approximation, considered as the harmonic oscillating.) It, of course, cannot represent a complete, exact meaning of basic Planck unit, but it represents a satisfactory, effective quasi-classical interpretation. As it is not hard to see such interpretation refers to future exact interpretation similarly to Bohr atomic theory, i.e. nave quantum theory of atom to exact, quantum mechanical theory of atoms.

Now we shall solve system of equations (1)-(4).

According to (1) it follows

$$e = (G4\pi\epsilon_0)^{\frac{1}{2}} m. \tag{5}$$

According to (3) it follows

$$R = \frac{Gm}{c^2}. \tag{6}$$

According to (4) it follows

$$\omega = \frac{mc^2}{\hbar}. \tag{7}$$

Introduction of (5)-(7) in (2), after simple calculation, yields,

$$m = (\frac{\hbar c^3}{G})^{\frac{1}{2}}. \tag{8}$$

Now, introduction of (8) in (5)-(7), after simple calculation, yields

$$e = (\hbar c 4\pi\epsilon_0)^{\frac{1}{2}} \tag{9}$$

$$R = (\frac{\hbar G}{c^3})^{\frac{1}{2}} \tag{10}$$

$$\omega = (\frac{c^5}{\hbar G})^{\frac{1}{2}}. \tag{11}$$

In this way unique, simple solution of the system of equations (1)-(4) is obtained.

As it is not hard to see m (8) is identical to Planck mass, e (9) - to Planck electrical charge, R (10) - to Planck length, while ω (11) is identical to inverse , i.e. reciprocal value of Planck time.

In conclusion it can be repeated and pointed out the following. In this work all basic Planck units (Planck mass, Planck length, Planck time and Planck electrical charge) are determined by solution of a simple system of quasi-classical dynamical equations that have particularly classical (Newton gravitational force, Coulomb electrostatic force), relativistic (equivalence principle) or quantum (Planck-Einstein formula) nature.

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